an operating positive displacement pump for which abrasives are pumped and a conformable valve insert is employed.

SUMMARY

[0009] A pump assembly is provided. The pump assembly has a valve-seat interface with a valve having a conformable valve insert about the valve and a valve seat defining a fluid path through the assembly. The conformable valve insert is configured for striking the valve seat for closing the fluid path and includes a circumferential component to accommodate deformation thereof upon the striking of the conformable valve insert upon the valve seat.

[0009a] In view of the above, according to a first aspect of the present application, there is provided a pump assembly comprising: a valve seat; a valve for striking said valve seat, the valve comprising a valve head; and a conformable valve insert about said valve head for contacting said valve seat during the striking, said conformable valve insert having a circumferential component to reduce radial strain of deformation of said conformable valve insert upon the striking, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate contact with said valve seat in a tapered manner upon the striking, said rounded abutment extending radially beyond said curved concave surface; wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

[0009b] According to a second aspect of the present application, there is provided a pump assembly comprising: a conformable valve insert; a valve having a

valve head comprising an exposed strike face and a circumferential recess, said circumferential recess accommodating said conformable valve insert; said conformable valve insert having a circumferential component, the circumferential component partially defining an outermost profile of said valve; and a valve seat to accommodate striking of said conformable valve insert and the exposed strike face, said valve seat having a robust region aligned with the exposed strike face and an adjacent region aligned with said conformable valve insert, the robust region of abrasion resistance exceeding that of the adjacent region; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the striking of the conformable valve insert at the valve seat in a tapered manner in advance of the striking of the valve seat by the exposed strike face, said rounded abutment extending radially beyond said curved concave surface; and wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

[0009c] According to a third aspect of the present application, there is provided a pump assembly for pumping an abrasive fluid and comprising: a valve seat; a conformable seat insert disposed at a surface of said valve seat; and a valve having a valve head and a conformable valve insert exposed at a surface thereof for striking upon said conformable seat insert; said conformable valve insert having a circumferential component, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the striking of the conformable seat insert in a tapered manner in advance of a striking of the valve seat by the valve head, said rounded abutment extending radially beyond said curved concave surface; and wherein said conformable

valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

[0009d] According to a fourth aspect of the present application, there is provided a valve for a positive displacement pump, the valve comprising: a head having a circumferential recess and configured for striking a valve seat within the positive displacement pump; and a conformable valve insert disposed within the circumferential recess for contacting the valve seat during the striking and having a circumferential component to reduce a radial strain of deformation of said conformable valve insert upon the striking, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate contact with said valve seat in a tapered manner upon the striking, said rounded abutment extending radially beyond said curved concave surface; wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the head.

[0009e] According to a fifth aspect of the present application, there is provided a conformable valve insert of a valve for sealing against a valve seat of a positive displacement pump, the conformable valve insert comprising a circumferential component to reduce a radial strain of deformation of said conformable valve insert upon the sealing, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the sealing of the conformable valve insert at the valve seat in a tapered manner in advance of a striking of the valve seat by a valve head to which the

conformable valve insert is attached, said rounded abutment extending radially beyond said curved concave surface; wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a side view of an embodiment of a valve for a pump assembly.

[0011] Fig. 2 is a side cross-sectional view of the valve of Fig. 1 taken from section 2-2.

[0012] Fig. 3 is a side cross-sectional view of an embodiment of a pump assembly employing the valve of Fig. 1.

[0013] Fig. 4 is an enlarged view of a valve-seat interface taken from 4-4 of Fig. 3.

[0014] Fig. 5 is an enlarged view of a valve-seat interface taken from 5-5 of Fig. 3.

[0015] Fig. 6 is an overview of an oilfield employing surface equipment including the pump assembly of Fig. 3.

DETAILED DESCRIPTION

[0016] Embodiments are described with reference to certain high pressure positive displacement pump assemblies for fracturing operations. However, other positive displacement pumps may be employed. Regardless, embodiments described herein employ a valve-seat interface wherein a valve or a valve seat are configured with a

CLAIMS

We Claim:

1. A pump assembly comprising:

a valve seat;

a valve for striking said valve seat; and

a conformable valve insert about said valve for contacting said valve seat during the striking, said conformable valve insert having a circumferential component to reduce radial strain of deformation of said conformable valve insert upon the striking.

2. The pump assembly of claim 1 wherein said valve comprises a recess for accommodating said conformable valve insert and an exposed strike face adjacent said conformable valve insert for directly meeting said valve seat during the striking.

3. The pump assembly of claim 2 wherein the circumferential component is one of:

a concave surface reducing an outermost profile of said conformable valve insert to less than a profile of an outermost edge defining the recess; and

a rounded abutment to initiate the contacting in a tapered manner in advance of the meeting.

4. The pump assembly of any one of the preceding claims wherein said circumferential component is a core mechanism disposed within said conformable valve insert and of a greater energy absorbing character than an adjacent body of said conformable valve insert.

5. The pump assembly of claim 4 wherein the core mechanism is an air filled coil.

6. The pump assembly of any one of the preceding claims for pumping fluid through a hydraulic fracturing system at an oilfield.

7. The pump assembly of claim 6 wherein the pump assembly is a first pump assembly and the hydraulic fracturing system further comprises at least one neighboring pump assembly coupled to the first pump assembly.

8. The pump assembly of claim 6 or 7 wherein the fluid includes an abrasive proppant therein.

9. A pump assembly comprising:

a conformable valve insert;

a valve having an exposed strike face adjacent a circumferential recess to accommodate said conformable valve insert; and

a valve seat to accommodate striking of said conformable valve insert and the exposed strike face thereat, said valve seat having a robust region aligned with the exposed strike face and an adjacent region aligned with said conformable valve insert, the robust region of abrasion resistance exceeding that of the adjacent region.

10. The pump assembly of claim 9 wherein the robust region is of a material selected from a group consisting of tungsten carbide and a ceramic.

11. The pump assembly of claim 9 or 10 wherein the adjacent region is of a material selected from a group consisting of hardened steel and urethane.

12. The pump assembly of any one of claims 9 to 11 wherein said conformable valve insert comprises a

circumferential component to reduce radial strain of deformation of said conformable valve insert upon the striking.

13. The pump assembly of claim 12 wherein said circumferential component is one of:

a concave surface reducing an outermost profile of said conformable valve insert to less than a profile of an outermost edge defining the circumferential recess;

a rounded abutment to initiate striking of the conformable valve insert at the valve seat in a tapered manner in advance of striking of the valve seat by the exposed strike face; and

a core mechanism disposed within said conformable valve insert and of a greater energy absorbing character than an adjacent body of said conformable valve insert.

14. A pump assembly for pumping an abrasive fluid and comprising:

a valve seat;

a conformable seat insert disposed at a surface of said valve seat; and

a valve having a conformable valve insert exposed at a surface thereof for striking upon said conformable seat insert.

15. The pump assembly of claim 14 wherein said conformable seat insert and said conformable valve insert are of a polymeric material.

16. The pump assembly of claim 14 or 15 wherein said conformable valve insert comprises a circumferential component to reduce radial strain of deformation of said conformable valve insert upon the striking.

17. A valve for a positive displacement pump, the valve comprising:

a head having a recess thereabout and configured for striking a valve seat within the positive displacement pump; and

a conformable valve insert disposed within the recess for contacting the valve seat during the striking and having a circumferential component to reduce a radial strain of deformation thereof upon the striking.

18. The valve of claim 17 wherein said head further comprises an exposed strike face adjacent said conformable valve insert for directly meeting the valve seat during the striking, the circumferential component being one of:

a concave surface reducing an outermost profile of said conformable valve insert to less than a profile of an outermost edge defining the recess;

a rounded abutment to initiate the contacting in a tapered manner in advance of the meeting; and

a core mechanism disposed within said conformable valve insert and of a greater energy absorbing character than an adjacent body of said conformable valve insert.

19. A conformable valve insert for sealing against a valve seat of a positive displacement pump, the conformable valve insert comprising a circumferential component to reduce a radial strain of deformation thereof upon the sealing.

20. The conformable valve insert of claim 19 wherein the positive displacement pump comprises a valve having a recess to accommodate the conformable valve insert and configured for striking the valve seat with an exposed strike face adjacent said conformable valve insert, the circumferential component being one of:

a concave surface reducing an outermost profile of said conformable valve insert to less than a profile of an outermost edge defining the recess;

a rounded abutment to initiate the sealing in a tapered manner in advance of striking of the valve seat by the exposed strike face; and

a core mechanism disposed within said conformable valve insert and of a greater energy absorbing character than an adjacent body of said conformable valve insert.

CLAIMS

We claim:

1. A pump assembly comprising:

a valve seat;

a valve for striking said valve seat, the valve comprising a valve head; and

a conformable valve insert about said valve head for contacting said valve seat during the striking, said conformable valve insert having a circumferential component to reduce radial strain of deformation of said conformable valve insert upon the striking, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate contact with said valve seat in a tapered manner upon the striking, said rounded abutment extending radially beyond said curved concave surface;

wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

2. The pump assembly of claim 1 wherein said valve head comprises a recess for accommodating said conformable valve insert and an exposed strike face adjacent said conformable valve insert for directly meeting said valve seat during the striking.

3. The pump assembly of claim 2 wherein the curved concave surface reduces an outermost profile of said conformable valve insert to less than a profile of the outermost radial edge of the valve head.

4. The pump assembly of claim 1 wherein said circumferential component further comprises a core mechanism disposed within said conformable valve insert, said core

mechanism being of a greater energy absorbing character than an adjacent body of said conformable valve insert.

5. The pump assembly of claim 4 wherein the core mechanism is an air filled coil.

6. The pump assembly of claim 1 wherein said pump assembly pumps fluid through a hydraulic fracturing system at an oilfield.

7. The pump assembly of claim 6 wherein the pump assembly is a first pump assembly and the hydraulic fracturing system further comprises at least one neighboring pump assembly coupled to the first pump assembly.

8. The pump assembly of claim 6 wherein the fluid includes an abrasive proppant therein.

9. A pump assembly comprising:

a conformable valve insert;

a valve having a valve head comprising an exposed strike face and a circumferential recess, said circumferential recess accommodating said conformable valve insert; said conformable valve insert having a circumferential component, the circumferential component partially defining an outermost profile of said valve; and

a valve seat to accommodate striking of said conformable valve insert and the exposed strike face, said valve seat having a robust region aligned with the exposed strike face and an adjacent region aligned with said conformable valve insert, the robust region of abrasion resistance exceeding that of the adjacent region;

wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the striking of the conformable valve insert at the valve seat in a tapered manner in advance of the striking of the valve seat by the exposed strike face, said rounded abutment extending radially beyond said curved concave surface; and wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

10. The pump assembly of claim 9 wherein the robust region is of a material selected from a group consisting of tungsten carbide and a ceramic.

11. The pump assembly of claim 9 wherein the adjacent region is of a material selected from a group consisting of hardened steel and urethane.

12. The pump assembly of claim 9 wherein said circumferential component reduces radial strain of deformation of said conformable valve insert upon the striking.

13. The pump assembly of claim 12 wherein said curved concave surface reduces an outermost profile of said conformable valve insert to less than a profile of the outermost radial edge of the valve head; and wherein the circumferential component further comprises a core mechanism disposed within said conformable valve insert, said core mechanism being of a greater energy absorbing character than an adjacent body of said conformable valve insert.

14. A pump assembly for pumping an abrasive fluid and comprising:

a valve seat;

a conformable seat insert disposed at a surface of said valve seat; and

a valve having a valve head and a conformable valve insert exposed at a surface thereof for striking upon said conformable seat insert; said conformable valve insert having a circumferential component, the circumferential component partially defining an outermost profile of said valve;

wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the striking of the conformable seat insert in a tapered manner in advance of a striking of the valve seat by the valve head, said rounded abutment extending radially beyond said curved concave surface; and wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

15. The pump assembly of claim 14 wherein said conformable seat insert and said conformable valve insert are of a polymeric material.

16. The pump assembly of claim 14 wherein said circumferential component reduces radial strain of deformation of said conformable valve insert upon the striking.

17. A valve for a positive displacement pump, the valve comprising:

a head having a circumferential recess and configured for striking a valve seat within the positive displacement pump; and

a conformable valve insert disposed within the circumferential recess for contacting the valve seat during the striking and having a circumferential component to reduce a radial strain of deformation of said conformable valve insert upon the striking, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded

abutment to initiate contact with said valve seat in a tapered manner upon the striking, said rounded abutment extending radially beyond said curved concave surface;

wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the head.

18. The valve of claim 17 wherein said head further comprises an exposed strike face adjacent said conformable valve insert for directly meeting the valve seat during the striking, the curved concave surface reducing an outermost profile of said conformable valve insert to less than a profile of the outermost radial edge of the head; and wherein the circumferential component further comprises a core mechanism disposed within said conformable valve insert, said core mechanism being of a greater energy absorbing character than an adjacent body of said conformable valve insert.

19. A conformable valve insert of a valve for sealing against a valve seat of a positive displacement pump, the conformable valve insert comprising a circumferential component to reduce a radial strain of deformation of said conformable valve insert upon the sealing, the circumferential component partially defining an outermost profile of said valve; wherein the circumferential component comprises a curved concave surface reducing said outermost profile of said valve and a rounded abutment to initiate the sealing of the conformable valve insert at the valve seat in a tapered manner in advance of a striking of the valve seat by a valve head to which the conformable valve insert is attached, said rounded abutment extending radially beyond said curved concave surface; wherein said conformable valve insert does not extend outwardly beyond an outermost radial edge of the valve head.

20. The conformable valve insert of claim 19 wherein the valve head has a recess to accommodate the conformable valve insert and is configured for striking the valve seat with an exposed strike face adjacent said conformable valve insert, the curved concave surface reducing an outermost profile of said conformable valve insert to less than a profile of the outermost radial edge of the valve head; wherein the circumferential component further comprises a core mechanism disposed within said conformable valve insert, said core mechanism being of a greater energy absorbing character than an adjacent body of said conformable valve insert.